mon"; and the non-applicability to present visitors to the Devil's Dyke, of the remark that "there are bustards on the wide downs near Brighthelmstone"; and to those who spend their summer at Eastbourne, that "Cornish choughs abound and breed on Beachy Head, and on all the cliffs of the Sussex coast." A lengthy list of references is given with regard to the habits of the cuckoo, a subject on which further reliable information is much needed.

The typography, paper, and binding of the work are all that can be desired, and Bewick's drawings add further to its general interest.

OUR BOOK SHELF

Microscopical Notes regarding the Fungi present in Opium Blight. By D. D. Cunningham, M.B., Surgeon H.M. Indian Medical Service. (Calcutta: Office of the Superintendent of Government Printing. 1875.)

DR. CUNNINGHAM has devoted much care and attention to the study of the fungi present in the opium blight, and the results of his labours are given in the present pamphlet. The most important fungus present, and the one really causing the blight, is a species of Peronospora, and thus belongs to the same genus as our own too well-known potato-disease fungus. As in India the Peronospora affects the opium crop very seriously, it is a matter of the highest importance to have the life-history of such a pest worked out thoroughly by a competent observer. The *Peronospora arborescens*, which in India attacks the opium poppy, is to be met with in this country on the red poppy (*Papaver Rhœas*). Dr. Cunningham invariably found the Peronospora present in blighted leaves, and he describes fully the mycelium and the conidia of the fungus. The mycelium spreads through the intercellular spaces of the leaf, branches coming to the surface through the stomata, which ramify and produce the conidia. The conidia apparently do not produce zoospores. The sexual mode of reproduction by antheridia and oogonia was not observed, even although De Bary has already described the oogonia of this fungus. The life-history thus is imperfect, and we must urge Dr. Cunningham to persevere and not rest satisfied until he has observed the whole of the stages of this fungus.

After the parasite has done its work, the leaves of the poppy become infested with a number of other fungi, chiefly saprophytes, and Dr. Cunningham carefully describes and figures several of the forms.

W. R. M'NAB

Logarithmic and Trigonometrical Tables for Approximate Calculation. By J. T. Bottomley, M.A., F.R.S.E. (London and Glasgow: Collins and Co., 1875.)

THESE tables were primarily arranged by Mr. Bottomley for the use of the students of the Natural Philosophy Class in Glasgow University, but we believe many other students will feel grateful to the author for having published them.

An easy, handy book of tables such as this has been much wanted for Mathematical and Natural Philosophy Classes in the Universities and for advanced schools. There is no reason why, with a really convenient book, boys should not all learn logarithmic arithmetic as soon as they know decimals. But the books hitherto in use are too formidable. Moreover, practical calculators will find much use for four-figure logarithms, sines, &c., and many people who never use logarithms will be able to do so with ease when they have a four-figure table.

Mr. Bottomley has in this manual arranged (on the plan of De Morgan, we believe, who first applied it to logarithms) sines, tangents, logarithmic sines, and logarithmic tangents, and has printed them, with the logarithms and antilogarithms, each table on *two facing pages.*

We heartily approve of Mr. Bottomley's plan, and recommend his manual to all teachers and students who wish for an easily consulted scientific ready reckoner.

LETTERS TO THE EDITOR

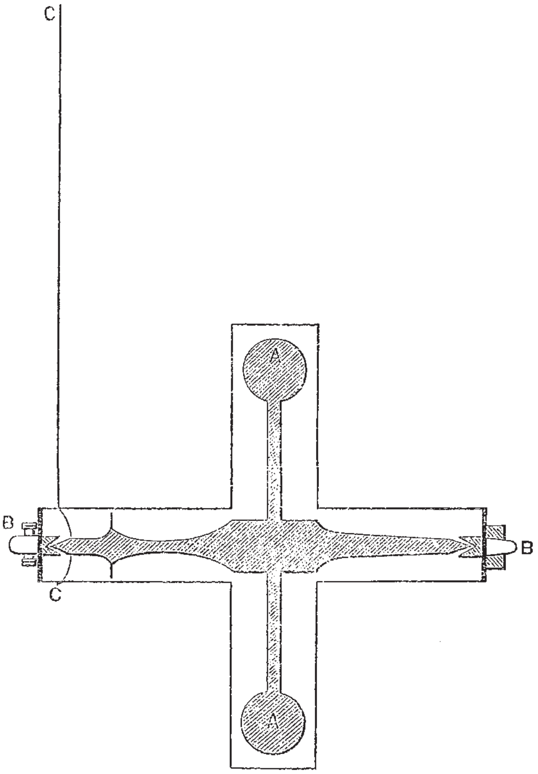
[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*]

A Gyrostat Problem.*—Answer

LET W be the weight of the fly-wheel.
k its radius of gyration.
ω its angular velocity in radians per second.
W' the weight of wheel and case together.
a the distance from the centre of inertia to the point of attachment of the string.
g the force of gravity.

The moment of momentum of the wheel round its axis is ωWk^2.

The rate of generation of moment of momentum round a horizontal axis perpendicular to the axis of the wheel, by the couple produced by the action of gravity and the tension of the cord by which the gyrostat is suspended, is equal to the moment of the couple (see Thomson and Tait's "Elements of Natural Philosophy," § 236), and is therefore, $g\,W'\,a$. Therefore the moment of momentum generated in a small time τ is $g\,W'\,a\,\tau$.



Compounding these two moments of momentum by the parallelogram of moments, we obtain—

$$\tan\theta = \frac{g\,W'\,a\,\tau}{\omega\,Wk^2}$$

where θ is the angle described in azimuth by the axis of the wheel in the small time τ; and since, when θ is small, $\tan\theta = \theta$, we have by the question—

$$\frac{g\,W'\,a\,\tau}{\omega\,Wk^2} = \tfrac{1}{4}\,\tau$$

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* For Problem, see NATURE, vol. xi. p. 385.

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Hence $\omega = \frac{4 g W' a}{W k^2}$ in radians per second.

Hence number of revolutions per second $= \frac{2 g W' a}{\pi W k^2}$

Substituting the numbers given in the question, we have for the answer—

$$\frac{2 \times 981{\cdot}4 \times 2250 \times 6}{3{\cdot}1416 \times 1800 \times 16}$$
$$= 293 \text{ revolutions per second.}$$

University, Glasgow D. M'FARLANE

The Sounds of the String Organ

MR. BAILLIE HAMILTON's invention of a conjoined string and reed which is now being carried out in a musical instrument to be called the string organ, has caused a marked interest both in its musical and in its scientific aspects. My attention was attracted to it strongly, for one reason, that it promised to add a new member to the family of keyboard instruments, and for another reason, that the study of its possibilities and practical working showed conditions so close in analogy to those of the organ-pipe as viewed under the theory advanced by me in NATURE, that the corroborative evidence thus furnished might with truth be called palpable. By the last word I refer to the visible displacement and travelling of the node, which can be affected at will in obedience to changes in the relative conditions of reed and string. I find that "tension" on the string is equivalent to "scale" in organ-pipes. To give high tension to a string is in effect the same as to use a narrow scale of pipe; thus, keeping the reed-force constant, we may respectively, by giving higher tension to the string, or by using a narrower pipe, drive the node higher, and conversely, slackening tension or using a wider scale of pipe, we may displace the node to a lower position. In the conjoined reed and string we can see this change taking place, order how it shall take place, and may clip the nodal point with our fingers without disturbance of the continuity of vibrations. The process is visible, the result tangible.

The estimate Lord Rayleigh * has given of the instrument as "modified reed" is undoubtedly right, yet it can scarcely be said that the opposition estimate is undoubtedly wrong. An orthodox organ is a pipe-instrument, and also is a wind-instrument, yet in acoustical relations the pipe is out of theoretical conformity, is a modified pipe; the air-reed likewise, according to the kind of pipe it is allied with, is a modified reed, and similarly in this novel organ the string and reed modify each other; sever the union, and the manifestations of the two independent forces will be wholly different. Specifically it is a wind-instrument, and I cannot but think we should admit it to be both "modified reed" and "modified string;" they work together as a system, each contributing its own character, and each in degree determining, through compromise and affinity, the issue of the union. Strongly impressed with this belief, my explanations will consequently differ from those generally current concerning this ingenious combination.

Lord Rayleigh, in explanation of his estimate, says, "the intermittent stream of air, which does not take its motion from the reed, gives rise to a highly compound musical note." Either I do not understand this affirmation, or I misunderstand it; I have always considered the intermittence of the stream to be the result of the reed's motion. And further on, another sentence to strengthen his distinction: "The fact that the *pitch* of the system is mainly dependent upon the string seems to have distracted attention from the important part played by the stream of air, and yet it is obvious that wind cannot be forced through such a passage as the reed affords without the production of sound." Speaking, not without experience in varieties of free reeds, I cannot recall a single instance of the wind forced through the passage afforded by the reed producing anything like a musical sound. Our views probably differ in expression and in interpretation more than in perception.

With some temerity I think I may say that the working of the free reed is not fairly estimated by scientific observers. It is generally supposed that the *pressure* of the wind originates the vibration of the reed in instruments, whereas the fact is that the free reed may be so set that although perfectly free to pass, as may be seen on holding it up to the light, perfectly free to sound, as may be proved by percussion, yet, placed within the instrument, it will be dumb to all pressure of the wind. The essential condition for speech is for the reed to be so set that a sufficient amount of air shall with velocity pass the sides and through the mortice of the reed equal to causing a suction on the under side of the reed; then only will the reed proceed on its course, and the check given to the stream when the reed reaches the level of the block intensifies the suction, the development whereof progresses until the back-lash or return of the reed creates a stronger partial vacuum with a promptness of power effectual for establishing the condition of vibration. There are peculiarities, too, in the process of the suction, not lightly to be passed over by the scientific observer. The true test of action is the degree of quickness in speech. The most prompt articulation is that in which the process of suction is most gradual; this is not paradoxical, though it may seem so. If a large amount of wind is allowed to pass, the action will be sudden, yet, notwithstanding, the speech, comparatively estimated, will be slow. The suction should first attack the tip of the reed and gradually draw upon the stem. If you allow passage to the wind near the root of the reed, or if you hollow or arch the stem, permitting wind more freely to pass the middle of the reed, it is inevitably at the sacrifice of quickness of speech, and nothing is more fatal than allowing extra opening for a rush of air between the tip of the reed and the frame, for you thereby impair the perfectness of the suction at its most vital point.

In the case of a reed and string conjoined, the string is a weight to be moved; the force of wind will effect the displacement if the string has held the reed in position to allow passage of wind; and when the equilibrium of the string has been in the least degree disturbed, the return motion becomes a source of additional impetus, inducing the reed to follow by reciprocation; yet even here we do not escape the demand for suction; the value for this purpose of a tube or a channel beyond the reed is as evident as in the harmonium. The difference between the modern harmonium and the old seraphine is, that the former has pipes or channels to every reed, the latter had its reeds placed over apertures in plain boards; the reed conjoined to a string when so placed over a simple aperture will sound as would the reed in the old seraphine, but generally with the exhibition of the same defect, slowness of speech. Select an instance of such a string and reed so sluggish that the attainment of speech to the semblance of a musical note is a trial of patience; then add a tube of suitable character, and, in comparison of condition, the promptitude of response and power of tone will give certain evidence of its value, for here, as in all musical instruments, the function of the tube is to aid and to develop more strongly the force of suction. The suction I mean is that which is caused by the issue of a current of compressed or condensed air into the atmosphere.

A very curious problem is afforded in the peculiar quality of tone given by the new mechanical action of "reed-and-string" working linked together, and I have not heard, from any of the numerous thinkers and observers who have commented upon it, a satisfactory solution. Lord Rayleigh truly states, "it is certain that the note actually heard is compound," and also that "the peculiar character of the string, that its notes form a harmonic scale, does not come into play."

What is it, then, that we hear, and how comes this highly compound musical note into being? Let me offer this solution, if only as a suggestion. It is generally agreed that "there is a great deal of octave in the tone," sometimes the fifth, and frequently and most strikingly a beautiful major tenth, so clear that it seems to sing away by itself as if in independent existence; this, whilst it is certain that the string is not vibrating in forms either of the octave, fifth, or tenth or of any other of the accessory tones so often present to the ear. Rightly to apprehend the action of strings in musical instruments, it is, I think, desirable to regard every string as a tuning-fork acting upon the sound-board through the bridge, which, thus considered, is its stem for the communication of its vibrations. The intensity of sound from a tuning-fork or from a string depends not alone on amplitude of movement, but on pressure, the amount of such pressure being mainly determined in the case of the string by the angle the string makes in its strain upon the bridge under the particular tension to which it is subjected. A tuning-fork sounds loudly or softly, according as its stem is pressed strongly or lightly by the hand upon the sound-board. A string deflected right and left delivers each way its pulse through the bridge to the sound-board; a free reed, moving forward and backward, gives an effective impulse as musical vibration one way only—in the back-lash, or return; consequently, in this matter of conjoined reed and string, it appears to me we have always two fundamentals—two tones

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* See NATURE, vol. xi. p. 308.

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